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Division of Research
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Indiana's economy has been experiencing the stress of slow domestic automobile sales. Suggestions of a coming recession make the unemployment rate a topic of growing interest. Gerald Lynch and Thomas Hyclak offer an analysis of Indiana's experience during previous recessionary periods to explain the swings in unemployment within this state. If their findings, based on technical work detailed in an Appendix, are correct, the unemployment problems of the state in expansionary periods are very different from those in recessionary times.

The sensitivity of the state's economy to swings in national economic performance is also seen in the latest estimates of Gross State Product (GSP) produced by Louis West. These figures for 1978 add to the body of data recently provided in this *Review*.

What gives value to a home? As expected, in today's world we are seeking answers from computer-assisted models. Alan Reichert and Chien-Ching Cho offer an introduction to computer-based analysis of housing values with their work for a section of Fort Wayne. Other efforts at computerized appraisal are in progress throughout the nation. This tool will assist professionals in real estate without displacing the elements of judgment and experience.

MJM

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A Comparison: Indiana and U.S. Unemployment Rates During Recessions

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Since 1950, Indiana's average unemployment rate has been lower than that for the United States (4.81% vs. 5.14%). Yet, whenever the country is in the depths of a recession Indiana's unemployment rate creeps above the national rate. This happened in 1954, 1958, 1970, and 1975. With government economists predicting a mild recession for 1980, the questions arise, Why does Indiana's unemployment rate rise above the nation's? and How severe must the recession be before Indiana's unemployment rate is higher than the nation's?

First, the question of why Indiana's unemployment rate rises above that of the U.S. This paper uses a simple variant of Okun's Law[1] to explore the relationship between unemployment and Gross National Product and finds that the reason for the discrepancy is that Indiana's unemployment is a different type than that of the nation as a whole.

Economists generally separate the causes of unemployment into three components. *Cyclical unemployment* increases during business recessions and declines as the economy recovers. If the economy is producing at its full potential there should be no cyclical unemployment and the economy is considered to be at full employment. *Structural unemployment* is caused by factors such as geographic shifts in employment that lead to mismatches between the requirements of existing vacancies and the skills of those unemployed. *Frictional unemployment* is often termed voluntary in that some people find themselves temporarily unemployed as a result of decisions to leave one job in order to find another.

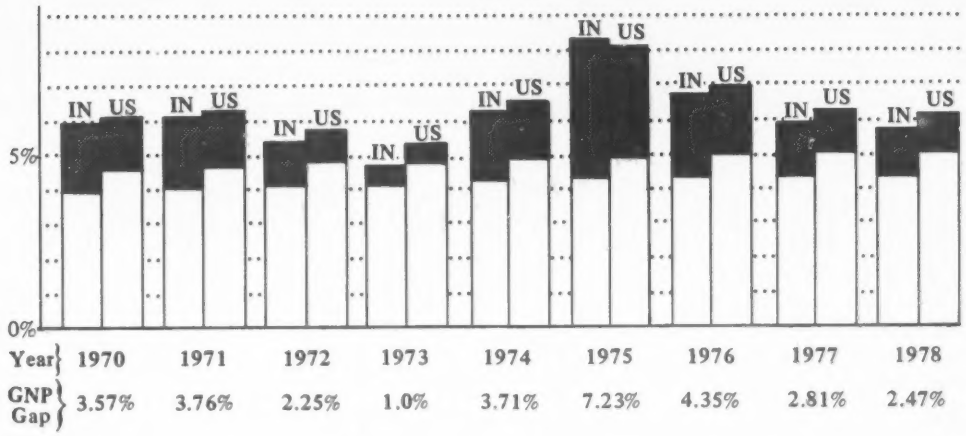
In practice, it is difficult to separate structural from frictional causes of joblessness; therefore, we separate unemployment into only two components: cyclical and structural-frictional. When unemployment is reduced to only structural-frictional unemployment the economy is fully employed because further increases in aggregate demand can do little to reduce structural-frictional unemployment.

The familiar macroeconomic relationship known as Okun's Law relates unemployment to the GNP gap[2] and allows a breakdown of unemployment into its two components. By examining Okun's Law through the statistical technique of ordinary least squares regression analysis, Indiana's unemployment rates for the

[1] For a full presentation of the model, see Appendix 1.

[2] For a definition of the GNP gap, see Appendix 1.

Proportions of Structural-Frictional and Cyclical Unemployment in Indiana and the U.S.: 1970-1978.


IN US
5%
0%
Year 1970 1971 1972 1973 1974 1975 1976 1977 1978
GNP Gap 3.57% 3.76% 2.25% 1.0% 3.71% 7.23% 4.35% 2.81% 2.47%
Cyclical Unemployment
Structural-Frictional Unemployment

years 1950-78 were compared to the national unemployment rates.[3] The findings give some evidence as to why Indiana has lower average unemployment rates than the nation but suffers more during recessions.

Indiana appears to have a structural-frictional unemployment rate, that is, a full-employment unemployment rate, about .85 of that of the United States as a whole. Thus, if full employment for the nation is 6.0%, it is about 5.1% for Indiana. However, Indiana's unemployment rate is more cyclically sensitive than that of the nation and whenever the gap between actual and real GNP widens due to a recession, statewide unemployment increases more rapidly than national unemployment. Relying on the GNP gap as a measure of the severity of a recession, Indiana's unemployment rate has exceeded that national rate only in the depths of a recession, the years previously mentioned. The bar graph shows the proportion of unemployment that has been structural-frictional and that which has been cyclical in the years 1970-78. The structural-frictional rate for Indiana is always lower than that same rate for the United States. However, the cyclical component varies with the size of GNP gap listed on the graph. Whenever the GNP gap increases by 1%, the unemployment rate in Indiana increases by .56 while the unemployment rate for the United States increases by only .47. When the gap is great enough, the larger amount of cyclical unemployment for Indiana eventually overshadows the lower structural-frictional unemployment and the total state unemployment rate surpasses the national rate.

How severe must the recession be before Indiana's unemployment rate is higher than the nation's? If we assume that the full-employment unemployment rate is 5.14%, the 1978 rate, the GNP gap would have to be 5.85% before Indiana's unemployment rate would exceed the national rate. The GNP gap was 7.23% in 1975, 3.57% in 1970, and 5.97% in 1958. Thus, for Indiana's unemployment rate to exceed the national rate a downturn roughly as severe as the 1958 recession would have to occur. This would result in an unemployment rate of 7.66% for Indiana.

[3] For a full listing of all of the sources of data used, see Appendix 2.

The high cyclical responsiveness of Indiana unemployment rates when compared to U.S. rates can be partially explained by the state's relatively high proportion of manufacturing employment and employment in the cyclically sensitive automobile and auto-related industries. Durable manufacturing activity has been linked to regional business cycles by Browne and others. For example, in May 1978 about 26% of Indiana's workers were employed in durable goods manufacturing, and about 5% of the state's workers were employed in the transportation equipment industry. In comparison, 14% of U.S. workers were employed in durable goods manufacturing and 2.2% were employed in transportation equipment manufacturing.

Indiana's lower structural-frictional unemployment rate may be attributed to level of education. A higher proportion of the Indiana work force than of the national work force has completed high school. This suggests a more mobile and well trained work force.

Summary

Indiana benefits from lower structural-frictional unemployment. The state's problem of high unemployment during a recession is tempered by its rapid decreases in unemployment when the national economy recovers.

APPENDIX 1

Okun originally formulated the relationship between unemployment and the GNP gap as:

$$U_t = a + b\ Gap_t \qquad (1)$$

Where U_t is the unemployment rate and *Gap* is the GNP gap at time period t. The GNP gap is measured as the difference between actual real GNP and potential real GNP[4] expressed as a percentage of actual real GNP. Since the real GNP is an estimate of the nation's output of goods and services, as the gap between actual and potential real GNP widens due to a recession, the demand for labor is expected to fall, thus causing an increase in unemployment. The coefficient b shows the extent to which the unemployment rate responds to changes in the GNP gap.

Since the second term of the equation controls for the cyclical determinants of unemployment, the intercept term a is an estimate of structural-frictional unemployment. In Okun's original formulation, a was assumed to be equal to 4.0, which was the most widely accepted estimate of the full employment rate in the early 1960s. Okun then estimated b to be equal to .33, suggesting that a 3% decrease in the GNP gap would be necessary to reduce the unemployment rate by one percentage point.

More recently, economists have come to agree that the full-employment unemployment rate has not been constant at 4.0% of the work force but has been steadily rising. This rise has been attributed to the growing proportion of women and teenagers in the work force. As a result, Tatom has introduced a revised version of Okun's Law:

$$U_t = UF_t + b\ Gap_t \qquad (2)$$

where UF_t is the full employment or structural-frictional unemployment rate. Tatom's version of Okun's Law allows for a variable intercept that takes into account the effect of demographic changes in the labor force on unemployment rates. Tatom estimates b to be around .45, which implies that slightly more

[4] Potential GNP is the value of GNP that could be attained if the economy were at full employment. It should be noted that this is an amorphous concept that does not have complete acceptance in the economics profession. Further discussion, both pro and con can be found in Okun, Perry, Rasche and Tatom, and Lucas.

than a two percentage point reduction in the GNP gap would reduce the unemployment rate by one point.

We apply Tatom's model to an analysis of unemployment rates in Indiana. The model is:

$$U_t^i = b_1 UF_t^{US} + b_2 Gap_t^{US} \qquad (3)$$

where U_t is the annual unemployment rate in the state of Indiana, UF_t is the full employment rate in the U.S., and Gap_t is the real GNP gap for the U.S. Since data are not available for the state full-employment unemployment rate, we attempt to estimate that rate by the first term on the right hand side of equation (3). We assume that the state full-employment unemployment rate is related to the national rate. In so doing, we have assumed a constant ratio between the full-employment unemployment rate for the state and that for the U.S. as a whole. It is possible that the composition of the labor force in the state has changed in a different manner than the labor force of the entire U.S. If that has occurred the assumption of a constant ratio does not hold up and the equation is misspecified. This may account for the low Durbin-Watson statistic for the state, although the Durbin-Watson is still not significant. For the U.S. b_1 should be equal to one, in which case equations (2) and (3) are equivalent.

For an individual state b_1 may be greater than or less than one. If b_1 is greater than one, the full-employment unemployment rate for that state exceeds the national rate. The coefficient b_2 indicates the responsiveness of local unemployment rates to the national business cycle. A higher value for b_2 indicates that that state experiences more cyclical unemployment than the nation as a whole for any given business downturn.

The empirical results reported below show that Indiana's full-employment unemployment rate is .85 that of the national rate. Indiana's cyclical responsiveness to a one percent increase in the GNP gap is greater than that of the U.S. (.56 vs .44). All variables are statistically significant at one percent and the entire equation has strong explanatory power as indicated by the high R^2 values.

APPENDIX 2–SOURCES OF DATA

Indiana and the United States Unemployment Rates are annual figures for the years 1950-78. **Source**: *Survey of Current Business*, Bureau of Economic Analysis, Department of Commerce. Various issues.

Regression Estimates of the Unemployment Model

$$U_t^i = b_1 UF_t^{US} + b_2 Gap_t^{US}$$

	b_1	b_2	R^2	F	DW
United States	.986698	.44189	.95	246.8	1.82
	(16.2)	(7.58)		Rho = .5779	
Indiana	.850983	.56044	.98	709.3	1.47
	(22.3)	(9.77)			

Real Gross National Product, annual figures for the years 1950-78. **Source**: *Economic Report of the President*, Council of Economic Advisors, Washington, D.C. (January, 1979).

Potential Gross National Product. **Source**: Rasche, Robert H. and Tatom, John A. "Energy Resources and Potential GNP," *Federal Reserve Bank of St. Louis Review* 59 (June 1977).

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Indiana Gross State Product—1978[1]

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The Division of Research has recently received revisions for state personal income and farm income data as well as new figures for estimating gross state product for 1978. (See table on page 7.)

In current dollars most sectors of Indiana's economy grew substantially in 1978. Farm and mining were the exceptions. In real terms (adjusted to real dollars by use of the GNP deflator corresponding to each sector), while the increase in Indiana's GSP of 3.9% compared favorably with the 1977-78 growth in real GNP of 4.6%, the state's farm and mining sectors slumped badly. An examination of GSP as a percent of U.S. GNP by industrial sectors confirms both this loss of national share for those two sectors as well as the relatively stable share for the state as a whole.[2] The graph on page 8 shows Indiana's GSP as a percentage of U.S. GNP for 1958 through 1978. Indiana's share of the national economy, grew erratically

[1] This article updates previous estimates of Indiana's gross state product (GSP). Louis West, "Indiana's Gross State Product," *Indiana Business Review*, 55 (1980): 9-11.

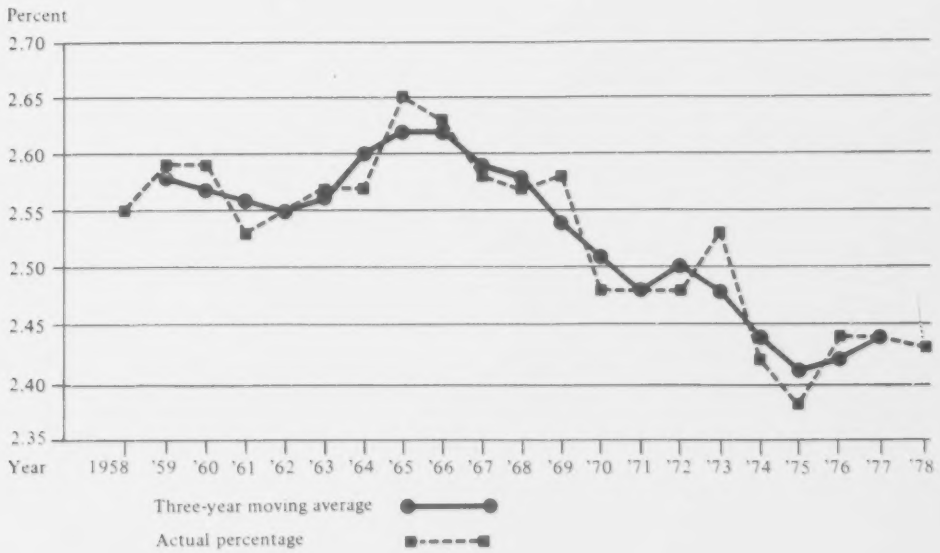
[2] The six-page computer printout of data for 1958-1978 is available from the Division of Research without charge.

Indiana Gross State Product: 1977 and 1978

	Millions of Current Dollars		Percentage of U.S. GNP		Percent Distribution		Annual Rate of Nominal Growth (percent)		Millions of Constant (1972) Dollars		Annual Rate of Real Growth (percent)	
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978
Farm	1,775.1	1,852.7	3.61	3.11	3.82	3.58	−7.58	4.37	1,239.3	1,063.7	−7.51	−14.16
Mining	534.0	570.7	1.11	1.04	1.15	1.10	9.75	6.87	220.0	215.7	−0.06	−1.95
Contract Construction	2,066.4	2,363.8	2.47	2.48	4.45	4.56	18.36	14.39	1,400.9	1,468.2	11.14	4.79
Durable Manufacturing	13,628.9	15,623.7	4.97	5.00	29.35	30.16	16.36	14.63	9,572.3	10,185.4	8.45	6.40
Non-Durable Manufacturing	4,006.1	4,337.5	2.20	2.21	8.63	8.37	10.61	8.27	2,934.4	3,041.9	7.80	3.66
Trade	7,291.4	8,029.8	2.26	2.23	15.70	15.50	9.55	10.12	5,145.8	5,325.8	4.76	3.49
Finance Insurance Real Estate	5,061.6	5,476.5	1.89	1.83	10.90	10.57	11.48	8.19	3,890.2	3,962.6	4.98	1.86
Transportation Communications Utilities	3,765.8	4,227.9	2.24	2.22	8.11	8.16	12.14	12.27	2,794.2	2,978.3	5.95	6.58
Services	4,213.8	4,768.4	1.79	1.77	9.07	9.21	14.74	13.16	2,861.5	3,001.2	6.43	4.88
Government	4,016.8	4,457.6	1.69	1.72	8.65	8.61	8.87	10.97	2,801.4	2,903.1	1.24	3.63
Other	74.5	88.1	1.26	1.24	0.16	0.17	19.82	18.36	49.7	56.3	5.44	13.09
TOTAL	46,434.9	51,797.2	2.44	2.43	100.00	100.00	11.98	11.54	32,910.1	34,202.7	5.73	3.92

until 1965, dropped in 1970, and fell steadily from 1973-75. In the last three years Indiana's share of the national economy has leveled out. These patterns tend to correspond roughly to national business cycles. Generally within a year of the full onset of the last three national recessions (1960, 1970, 1974) Indiana's GSP fell with respect to U.S. levels. This drop in share of GNP suggests that Indiana's economy is more sensitive, therefore more volatile, during periods of national decline. There is also indication in these figures of a long-term, gradual decline in Indiana's share of the nation's output.

Indiana Gross State Product as Percentage of U.S. GNP



A Statistical Approach to Real Estate Appraisal: An Analysis of the Fort Wayne Market

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INTRODUCTION

For many years, real estate values in the Fort Wayne market have lagged behind those in other cities in the nation. Recently this gap has begun to close. In Fort Wayne the average price of a new home during 1977 was $52,377. The city's monthly average recorded for April 1979 was $66,600–almost in line with the national average of $71,300[1]. Fort Wayne is a growing city and is in the process of annexing several existing subdivisions. Development of many new subdivisions is underway.

NOTE: The authors are indebted to Kevin Allen, an I.U.-Bloomington student, for his assistance in gathering the data for this study.

[1]SOURCE: Department of Housing and Urban Development and Department of Commerce, Bureau of the Census, Construction Reports, *New One-Family Houses Sold and For Sale*, May, 1979, plus Fort Wayne MLA, April, 1979, real estate activity summary report.

Increases in real estate activity have expanded the amount of data available to Fort Wayne's real estate appraisers. The trends mentioned above underscore the need for more efficient, economical, and objective methods of analyzing this data.

Cost and market-value approaches are the traditional means for real estate valuation. Both methods are commonly employed, either individually or together, when appraising single-family housing. The appraiser who uses the cost approach first calculates the value of the land, then proceeds to add a reasonable estimate of the depreciated reproduction cost of the house and other improvements. The appraiser who uses the market-value approach compares the subject property with other properties that have recently been traded in the market and that are similar with respect to age, construction, condition, location, etc.

Within the last ten years multiple regression analysis has become increasingly popular. Multi-

ple regression analysis is a statistical technique that was developed to measure the joint effect of two or more independent variables upon a dependent variable. In a real estate appraisal application the independent variables are the locational and structural characteristics of the house. The dependent variable is the final selling price of the property under consideration. Our purpose is to illustrate how multiple regression analysis can be employed as a tool for determining the market value, i.e., predicting the selling price, of single-family homes in the Fort Wayne market. We make no attempt to rigorously discuss or to resolve a number of the complex theoretical and statistical problems that are widely recognized in the current appraisal literature. Our objective is to bring this relatively new approach to the attention of practitioners in the appraisal field and to generate additional interest and further research in the use of multiple regression analysis in real estate appraisal.

THE DATA BASE

Data for this study consisted of a random sample of 201 sales reported in the 1978 sales book of the Multiple Listing Association (MLA) of Fort Wayne. The sample was drawn from a population of several thousand houses sold in the northeast quadrant of the city. This northeast quadrant comprises older houses located not far from the downtown area and newer houses located in a number of rapidly growing suburban areas. Since the model is designed to appraise the typical single-family home, properties that possessed highly unusual or unique characteristics, i.e., houses 50 years old or older, properties with excessively large lot sizes, houses with unusually spacious living areas, etc., were omitted from the sample.

The property characteristics selected in the model were limited to those variables reported in the MLA listing book. Twenty-three locational and structural characteristics that might have a significant influence upon selling price were identified.

Locational Characteristics

The importance of location in real estate appraisal is well-known. In an effort to estimate locational impact, three variables, ADD (addition), CITY, and WOODED were included in the model. The entire sample of homes was categorized into five types of addition: exclusive, good, average, poor (or questionable), and others. The "others" group included a large number of homes that either were not located in a platted subdivision or were in a subdivision whose characteristics were unknown. Local realtors were asked to rank from poor to exclusive the larger more readily identifiable additions. The variable CITY was used to identify whether or not the property was located within the Fort Wayne city limits and was included in the model to help measure the net influence of city services, taxes and locational factors upon real estate values. Generally, homes located on wooded lots and those adjacent to forested areas command a higher price in the market. Based on property descriptions in the MLA listing book, each home was classified as having either a wooded or an unwooded lot.

Structural Characteristics

Eighteen variables were selected to measure the unique structural characteristics of a property.

As a rough measure of condition the age (AGE) of the house was recorded in years. Newly constructed houses that had been sold for the first time were treated separately and designated by a NEW house variable. Rather than simply assigning a zero value to age, this NEW house variable was employed in an attempt to identify the value of a buyer-decorated or designed house, plus the possible psychological advantages a new house may

possess. Furthermore, new houses typically lead the market in a period of rapidly rising construction costs.

A variable labeled SEWER was included to designate whether or not the property had sewer or septic facilities. The type of foundation (FOUND) was identified as basement (full or partial), crawl space, or slab. Both type and age of the present heating system were included: type was categorized as gas, electric, oil, or others; age was recorded in years. Garage size (GARAGE) was measured in square footage. The lot size (LOTSZ) was measured in square feet for each property and was estimated from the available information. Four basic groups—all aluminum, all wood, masonry, or some combination—categorized the type of siding (SIDING) used in construction.

Several variables were used to measure both the amount and the allocation of living space available for each house. These variables included: the size of the total living area measured in square feet (SQFT), and the total number of rooms (TOTRMS), total number of bedrooms (BEDRMS), and total number of baths and half-baths (BATHRMS). Construction style (STYLE) was identified as: ranch, two-story, or other (tri-level, Cape Cod, duplex, etc.). The variable AIRCOND designated whether or not the house had a built-in central air-conditioning system. The variable FIREPLACE indicated another popular feature—a built-in fireplace. A remodeled kitchen typically will include either a built-in dishwasher or garbage disposal or both and generally will add to the value of a house; thus, the two variables, DISHWASHER and DISPOSAL, were included to capture the effect of a modern, remodeled kitchen. Two additional variables included in the model measured the impact of financing available and the current rate of inflation. The variable TERMS incorporated the influence of two major types of financing options, cash/conventional and assumable loans, that were available for each property. MONTH indicated the month in which the house was sold. The regression coefficient associated with this variable approximates the average monthly dollar inflation rate for homes in the northeast quadrant during 1978.

A base category was established for each of the categorical variables identified above; the regression coefficient associated with each of the remaining groups indicates the market value of that category relative to the designated base. For example, the regression coefficient for FIREPLACE indicates the additional market value associated with having a built-in fireplace since a house without a fireplace was designated as the base. The base category for the foundation variable (FOUND) is a house built on a slab, and the regression coefficients for crawlspace and basement represent the additional market value associated with these types of foundation. Table 1 provides a list of selected characteristics for our sample of 201 homes.

THE MODEL

Our multiple linear regression model has the general form:

$$Y = a + b_1 x_1 + b_2 x_2 + \ldots b_k K_k$$

where Y is the calculated value of the final selling price, and the x's are the various property characteristics discussed above. The constant term a and the regression coefficients $b_1 \ldots b_k$ are calculated during the computer regression analyses. The constant term indicates the component of appraised value that is not related to the set of explanatory variables and that would be common to all homes regardless of their unique locational and structural characteristics. The regression coefficients for each of the continuous explanatory variables, such as lot size or age, indicate the average impact of an additional square foot of property or an additional year of age on the house's market value. To assist in identifying which of the 23

TABLE 1
Selected Housing Characteristics: Estimation Sample

Characteristics		*Mean*	*Standard Deviation*
CONTINUOUS VARIABLES:			
Age (Years)		10.8	11.1
Total living area (Sq.Ft.)		1,542	433
Lot size (Sq.Ft.)		11,905	5,216
Number of bedrooms		3.3	0.6
Number of baths		1.8	0.6
Selling price		$47,087	$16,250
CATEGORICAL VARIABLES:		(%)*	
Style	Ranch	59.2	
	Two story	29.9	
	Other	10.9	
Foundation:	Slab	70.1	
	Crawlspace	11.0	
	Basement	18.9	
Sewer		92.0	
Air Conditioning		43.8	
Fireplace		61.7	
Wooded lot		16.9	
New home		21.9	
Addition:	Exclusive	6.0	
	Good	12.9	
	Average	37.8	
	Poor/Undesirable	8.0	
	Other	35.3	
City		36.8	

*Percentage of sample houses with these structural characteristics.

explanatory variables should be included in the final predictive model, we used a stepwise approach that entered individual variables into the regression analyses according to their relative explanatory or predictive power. A 95% confidence level was selected to determine which variables appeared in the final model.

MODEL RESULTS

The coefficient of determination, $\bar{R}^2$, indicates that the set of 14 independent variables identified in Table 2 as statistically significant explain 90% of the total variation in selling price for our sample of 201 houses. All of the regression coefficients carried the expected sign. For example, SQFT and LOTSZ have positive coefficients that indicate that each additional square foot of living space or of lot size will add approximately $15.74 or $0.145 to a property's value. The negative coefficient on AGE indicates that an additional year of age tends to reduce the market value an average of $440 per year. The model results indicate that a house

with a FIREPLACE will sell for roughly $3,235 more than a comparable house without a fireplace. The negative coefficient on STYLE: OTHER (Cape Cods, tri-levels, etc.) reflects the fact that ranch is the base style category, and that it is generally less expensive to build a Cape Cod or a tri-level than a ranch with the *same* square footage, total number of rooms, etc.

The 1978 average monthly inflation rate of $405 translates into an annual increment of $4,860 and represents a 10.3% increase for the sample's typical home. The two ADDITION variables (EXCLUSIVE and GOOD) indicate the greater price that a house located in either of these categories would likely command over and above the price that the same house located in the AVERAGE base addition category would bring.

The above discussion concerning the proper interpretation of individual regression coefficients is for illustrative purposes only. Readers should not attach undue significance to the precise value of each individual coefficient. The presence of correlated housing features and possible interaction effects among the explanatory variables will generate coefficients that may not precisely indicate the true contribution of those variables to the final selling price of the house. For example, the results indicate that CITY is picking up the influence of certain factors that, on balance, have a favorable impact upon home values. Does this positive impact actually measure the net difference between the value of city services received and city taxes paid? The extent to which various non-linear relationships, micro-locational factors, and zoning regulations (such as sewer ordinances) are influencing the results is not clear. Even if one assumes that, in fact, the variable does measure the pure economic effect of annexation, the estimated regression coefficient properly should be interpreted as only a rough approximation of the actual effect. On

TABLE 2
Regression Results

Variables – in Order of Importance (x_i)	*Regression Coefficients (b_i)*	*Standard Errors*
Total living space (Sq.Ft.)	$15.74	$1.56
Age	– 440	46
Foundation: basement	9,070	1,047
Central air conditioning	2,645	871
Garage	14.00	3.19
Fireplace	3,235	957
Style: other	–4,151	1,218
Baths	3,532	1,236
Month	405	118
Addition: Exclusive	6,677	1,781
Good	3,284	1,223
Wooded	1,810	1,093
City	2,086	953
Lot Size (Sq.Ft.)	.145	.078
Constant	4,822	2,268

$\bar{R}^2$ = .90 (Adjusted coefficient of determination)
S = $5,067 (Standard error of the estimate)

the other hand CITY clearly is measuring some factor (or more likely the net effect of a group of factors) that indicates a positive relationship between city boundaries and housing values in our sample.

Furthermore, suppose that an identical sample of houses but a slightly different set of variables was used to estimate home values. One would not be surprised to see somewhat different coefficients for the variables *common* to both models since we are now attempting to measure the same effect (housing values) but are using a different measuring device or model. We would likely allocate housing value in a different manner between the two sets of explanatory variables even if both models were equally effective in their overall ability to forecast. In a statistical appraisal model fitting together the regressor variables as a logical "package" of explanatory terms is much more important than having each separate variable precisely measure its own individual contribution.

FORECASTING ACCURACY

To test the model's overall appraisal capabilities a randomly selected validation sample, composed of 24 houses not included in the original sample, was drawn.

To derive an appraisal estimate for a given house one simply needs to substitute the values for the independent variables into equation (1)

$$Y = a + b_1 x_1 + b_2 x_2 + \ldots b_k K_k$$

and calculate the sum. For example, one of the homes in our validation sample had the following structural and locational characteristics:

Total living space (Sq. Ft.)		1,561
Age (Yrs.)		9
Foundation: Basement	(Yes)	1
Central air conditioning	(Yes)	1
Garage (Sq. Ft.)		609
Fireplace	(Yes)	1
Style: Other	(No)	0
Baths		2
Month		9
Addition: Exclusive	(No)	0
Good	(Yes)	1
Wooded	(No)	0
City	(No)	0
Lot Size (LTSZ)		11,900

When these values are substituted we get:

$$\begin{aligned} Y = {} & \$15.74(1{,}561) - 440(9) + 9{,}070(1) \\ & + 2{,}645(1) + 14.00(609) + 3{,}235(1) \\ & - 4{,}151(0) + 3{,}532(2) + 405(9) \\ & + 6{,}677(0) + 3{,}284(1) + 1{,}180(0) \\ & + 2{,}086(0) + .145(11{,}900) + 4{,}822 \\ Y = {} & \$64{,}627 \end{aligned}$$

The forecasted selling price (Y) for this house was $64,627, but the actual selling price was $66,000—an underestimate of $1,373. We evaluated each house in our validation sample in this manner. Table 3 shows the average values for the validation sample and their associated prediction errors.

TABLE 3

Validation Sample Results

Average	
Forecast Price	$47,760
Actual selling price	47,513
Absolute error[1]	2,630
Percentage error[2]	5.5%
Sample size	24

[1] The average absolute error represents the average dollar difference between the selling price and the forecast price regardless of sign.

[2] The average percentage error is the ratio of the average absolute error divided by the average selling price.

SUMMARY AND IMPLICATIONS

The regression results we have described indicate that current multivariate techniques can be applied effectively in the real estate appraisal area. The extraordinarily high $\bar{R}^2$ result plus the logical size and sign of the regression coefficients suggest that this statistical technique is capable of both forecasting and allocating housing values on a logical basis. Given that the technique appears to be a workable approach for single-family real estate appraisal, a number of important applications are possible. The most obvious advantage of the technique is that it provides the real estate broker or the lender's real estate appraiser with a relatively simple, consistent, and unbiased approach toward appraisal. The multiple regression model could provide the user with an initial estimate of a property's current market value; the appraiser could then readily adjust this benchmark appraisal up or down depending upon his or her subjective evaluation of a variety of factors not included in the model. Furthermore, a consistent, objective set of coefficients used by all appraisers should reduce the time and cost involved in obtaining sound appraisal estimates and could help reduce the speculative element present in a growing number of real estate markets.

The second major application of multiple regression appraisal techniques lies in the field of property tax assessment. A taxing authority could record the significant locational and structural characteristics of the existing stock of housing under its jurisdiction and could virtually reassess its entire residential tax base in a matter of hours based upon the results of a series of regression models comparable to the one reported in this study. The local multiple listing associations in many major municipalities (including Fort Wayne) have already adopted computer-based data retrieval systems that easily could be modified to handle a variety of multiple regression programs currently on the market. Once again the advantages of consistency and objectivity are readily apparent. Furthermore, the ability to appraise and reassess at more frequent intervals would eliminate difficult adjustments necessitated by dramatic changes in the value of the tax base and would insure that local property tax receipts keep pace with inflation and with the rising cost of providing public services.

Regression analysis does have its problems and limitations. A number of complex statistical issues such as multicolinearity, interaction effects, simultaneous equation and reduced form estimation problems, plus identification of the most appropriate functional form, have not been addressed fully. At a less technical level, the multiple regression approach requires an extensive data base that must be updated continuously to provide the most reliable model possible. Even when the appropriate data base is available the model's ability to appraise or predict is somewhat limited since the model is best suited to appraise the (typical) single-family home. At the same time individual real estate brokers are faced with their own sets of data limitations, and their own margin of error in appraising is widely recognized. Thus each approach has its own unique data problems, but with the multiple regression approach the problems tend to be somewhat more subtle and technical in nature.

Furthermore, the current multiple listing price may or may not be a good indicator of a property's long-term intrinsic value, especially in the area of property tax appraisal. For instance, transaction costs are incorporated into the appraisal estimate in the form of average brokerage commissions. Additionally, short-term fluctuations in supply and demand conditions may force current market prices to deviate from their long-run equilibrium value. A good deal of additional research is needed to insure that the multiple regression approach

fulfills its inevitable role as a useful and effective tool for market price-appraisals and for property tax-appraisals.

Several other areas for research currently exist. Among these are the use of the multiple regression approach in the formulation and implementation of municipal annexation policy. Preliminary evidence gathered in our present study shows that the multiple regression technique may ultimately prove useful in helping to identify and quantify the relative costs and benefits associated with alternative annexation proposals.

Additional research to determine the temporal stability of the regression coefficients is necessary before reliable forecasts of future housing value can be achieved. At the same time, multivariate statistical techniques such as regression should ultimately prove useful in analyzing the interactions of changing preferences, construction costs, and alternative methods of financing in today's dynamic real estate market.

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